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LISTS OF SPECIES

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Snakes of Cerrado localities in western Bahia, Brazil

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Abstract: We present a list of snake species found in 10 municipalities in the Cerrado of western Bahia state, Brazil. One hundred and twenty individuals of 46 species from seven families were examined. We also present a new state record for the genus *Phalotris* Cope, 1862 and a candidate new species for the genus *Thamnodynastes* Wagler, 1830.

Key words: conservation; geographic distribution; inventory; reptiles

INTRODUCTION

The Cerrado is the second largest morphoclimatic domain of Brazil, covering about 22% of the territory and surpassed in area only by the Amazon rainforest (Eiten 1972; Ab'Saber 1977; Oliveira and Marquis 2002). The Cerrado forms a continuous block in central Brazil but is also present as small enclaves within other domains, presumably as remnants of a past, more extensive distribution (Cole 1960; Carneiro Filho 1993; Barbosa et al. 2007; Werneck 2011). Harboring a rich and endemic biota that is highly imperiled by the expansion of commercial agriculture (Cavalcanti and Joly 2002; Klink and Machado 2005; Jepson et al. 2010), the Cerrado is considered a global biodiversity hotspot (Mittermeier et al. 2000; Myers et al. 2000). It is estimated that about 40% to 55% of the Cerrado has been converted to croplands, pastures and plantation forests (Mantovani and Pereira 1998; Machado et al. 2004; Sano et al. 2010); nevertheless, this transformation has received less attention than deforestation in the Amazonian and Atlantic rainforests (Ratter et al. 1997; Marris 2005).

The western Bahia region, within the Cerrado domain, is undergoing an agricultural development and has been drastically transformed from an economic backwater in the 1970s into one of the largest soybean producing areas in Brazil (Brannstrom 2005; Mendonça 2006; Santos 2008). This development has resulted in a dramatic decline of natural habitats in the region (Rocha et al. 2009; Santos and Epiphanio 2009; Passos et al. 2010; Flores et al. 2012). It is estimated that the Cerrado in western Bahia declined from 73% in 1986 to 40% in 2002, with an annual rate of loss of 2.6%, or 239 km^2/year, while croplands and pastures increased annually by 18.3% (Brannstrom et al. 2008). A study using climate modeling algorithms revealed that the western Bahia region lies within a refuge of climate stability in the Cerrado, the Serra Geral de Goiás refugium (SGGR), suggesting it should receive high priority for conservation (Werneck et al. 2012). Unfortunately, like the Cerrado as a whole (Klink and Machado 2005), there are few protected areas in western Bahia: Parque Nacional das Nascentes do Rio Parnaíba, Estação Ecológica Serra Geral do Tocantins, Área de Proteção Ambiental Bacia do Rio de Janeiro, FLONA de Cristópolis, and Reserva de Vida Silvestre das Veredas do Oeste Bahiano (Agência Nacional de Águas et al. 2004). In addition, regional herpetofaunal assessments are incipient (e.g., Hamdan and Lira-da-Silva 2012).

Valdujo et al. (2009, 2011) found that (1) the amphibian assemblages in western Bahia are as diverse as those from the south-central portion of the Cerrado, (2) most species are typically found in Cerrado habitats, and (3) there are no regional endemics. Similarly, Recoder et al. (2011) recorded diverse reptile assemblages, but a large proportion of species had wide distributions with few local, Cerrado endemics.

Herpetofaunal sampling related to environmental assessment studies for hydroelectric projects has increased significantly in Brazil over the last 10 years, mainly in the north and west-central regions (Pavan and Dixo 2004; Vaz-Silva et al. 2007; Cintra et al. 2009; Silva Jr et al. 2009). In the Cerrado domain, these inventories have also been intensified because of the environmental licensing process; those in the west-central and northern regions of Brazil resulted from the construction of new hydroelectric power plants, while those in the Cerrado resulted from similar, but smaller licensing projects. Several other studies have also been conducted, involving research and university extension courses, or long-term studies in conservation units such as those of Recoder and Nogueira (2007), Sawaya et al. (2008), Valdujo et al. (2009), Recoder et al. (2011), Freitas et al. (2012), and Hamdan and Lira-da-Silva (2012). Herein we present a list of snakes from the Cerrado in western Bahia.

MATERIALS AND METHODS

The region comprises the sub-basins of the rivers Carinhanha, Corrente and Grande, all of which drain into the left margin of the São Francisco River (Secretaria de Recursos Hídricos do Ministério do Meio Ambiente 2006). The topography is flat, with elevations ranging from ca. 750–950 m, on top of a vast plateau variously called Espigão Mestre, Serra Geral de Goiás, Chapadão Ocidental Bahiano or Chapadão Ocidental do São Francisco (Villela and Nogueira 2011; Grohmann and Riccomini 2012). This plateau consists predominantly of sandstones from the Urucuia group (Cretaceous) on top of predominantly limestone deposits of the Bambuí group (Neoproterozoic) (RADAMBRASIL 1982; Campos and Dardenne 1997; Iglesias and Uhlein 2009). Mean annual rainfall is concentrated between October and April and is highest (~1,400 mm) in the west, but decreases to ~600 mm close to the São Francisco River in the Sertaneja depression (Depressão Sertaneja) to the east (Agência Nacional de Águas et al. 2004).

We analyzed 15 previous herpetological inventories, and included the municipalities of Barreiras, São Desidério, Correntina, Jaborandi, Cocos, Coribe, Santa Maria da Vitória, São Félix do Coribe, Serra do Ramalho and Canápolis (Figure 1).

The majority of the material used in this study was collected in 2009, 2010 and 2014 during wildlife

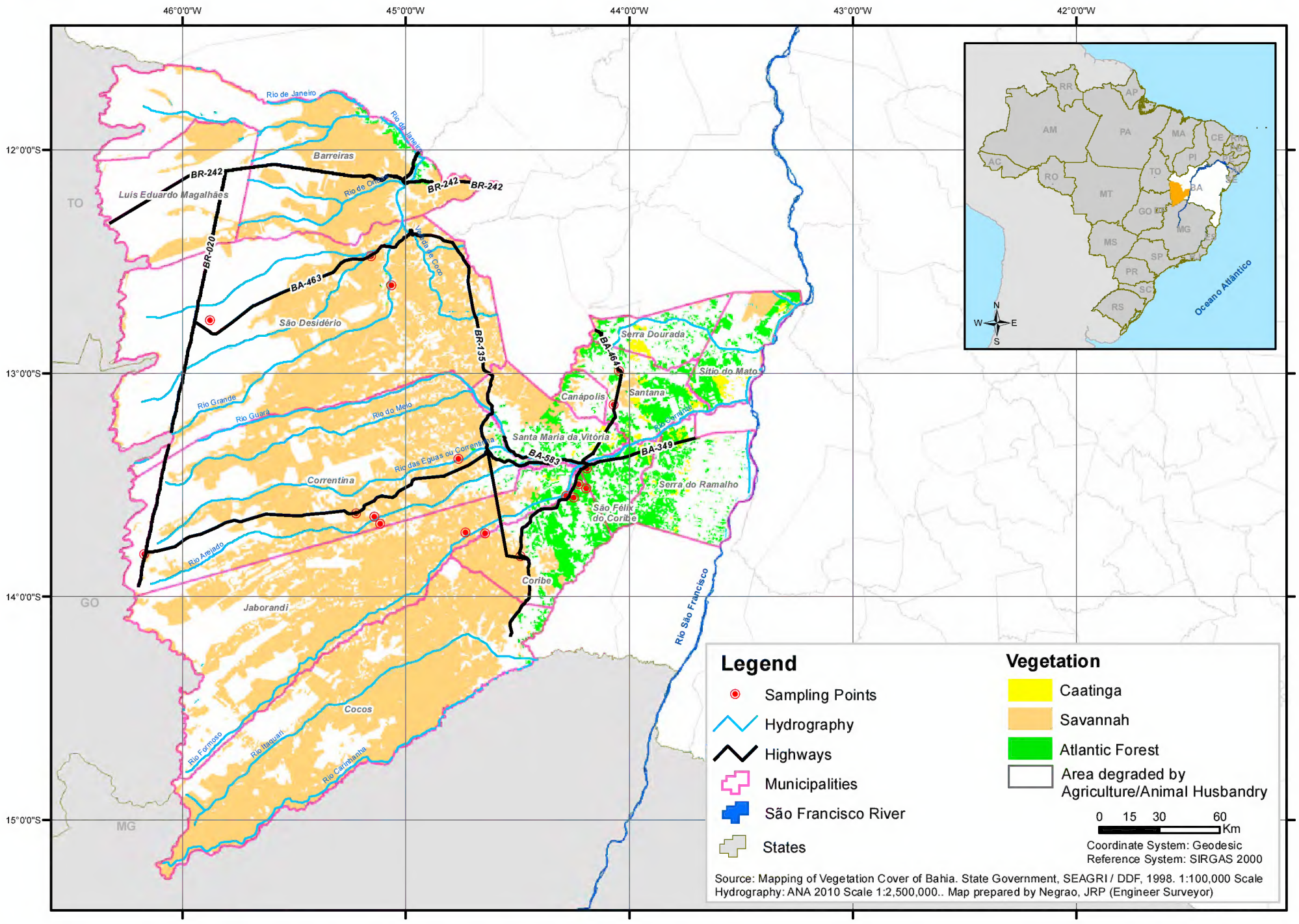

Figure 1. An overview of the study area in the Cerrado of western Bahia. Red circles are sampling points.

assessments for small dams, transmission lines and railway lines. Altogether, they comprised approximately 50 days of fieldwork, divided into five field campaigns with two to four people, using time-limited active search on suitable habitats and roads. The inventory also included photographic records of one of the authors (LT), an ornithologist and resident of São Desidério for 10 years. We also used records from the Coleção Herpetológica da Universidade de Brasília.

After collection, specimens were killed following the guidelines of the American Society of Ichthyologists and Herpetologists, fixed in 10% formalin, and subsequently deposited in the Museu de Zoologia da Universidade Estadual de Santa Cruz (MZUESC), Coleção Herpetológica da Universidade de Brasília (CHUNB) or Museu de Zoologia da Universidade de São Paulo (MZUSP) (Appendix 1). Collections in São Desidério were granted by Instituto Brasileiro de Meio Ambiente permit IBAMA/AUT.212/2009CGFAP – Process 02001.009713/2009-09. Collections also followed Articles 26 of IBAMA, Normative Instruction 119/2006 and Article 26 of IN 154/2007 of Instituto

Table 1. Snakes recorded from western Bahia, Brazil.

Family	Species	Municipalities
Anomalepididae	*Liotyphlops ternetzii* (Boulenger, 1896)	São Desidério
Leptotyphlopidae	*Trilepida koppesi* (Amaral, 1955)	Correntina
	Trilepida brasiliensis (Laurent, 1949)	Cocos
Boidae	*Boa constrictor constrictor* Linnaeus, 1758	São Desidério, Correntina, Santa Maria da Vitória
	Boa constrictor amarali Stull, 1932	Barreiras
	Epicrates assisi Machado, 1945	Santa Maria da Vitória, Barreiras
	Epicrates crassus Cope, 1862	São Desidério, Cocos, Correntina
	Corallus hortulanus (Linnaeus, 1758)	São Desidério
Colubridae	*Spilotes pullatus* (Linnaeus, 1758)	São Desidério
	Mastigodryas bifossatus (Raddi, 1820)	Correntina.
	Oxybelis aeneus (Wagler, 1824)	São Desidério, Cocos, Correntina
	Chironius flavolineatus (Jan, 1863)	Correntina
	Leptophis ahaetulla liocercus (Wied, 1824)	São Desidério, Coribe
	Tantilla marcovani Lema, 2004	São Desidério, Jaborandi, Cocos
Dipsadidae	*Taeniophalus* aff *occipitalis*	São Desidério, Cocos
	Apostolepis ammodites Ferrarezzi, Barbo & Albuquerque, 2005	Correntina, Cocos, São Desidério
	Apostolepis polylepis Amaral, 1921	São Desidério
	Philodryas nattereri Steindachner, 1870	São Desidério, Barreiras, Correntina, Santa Maria da Vitória
	Philodryas olfersii (Lichtenstein, 1823)	Correntina, Coribe, São Desidério
	Philodryas patagoniensis (Girard, 1858)	Cocos
	Philodryas agassizii (Jan, 1863)	Correntina
	Sibynomorphus mikanii (Schlegel, 1837)	Correntina
	Boiruna sertaneja Zaher, 1996	Santa Maria da Vitória, Jaborandi, Barreiras
	Oxyrhopus petolarius Reuss, 1834	Santa Maria da Vitória
	Oxyrhopus trigeminus Duméril, Bibron & Duméril, 1854	Santa Maria da Vitória, Jaborandi, Correntina, Cocos, São Desidério
	Oxyrhopus guibei Hoge & Romano, 1978	Barreiras, Correntina
	Oxyrhopus rhombifer rhombifer Duméril, Bibron & Duméril, 1854	São Desidério
	Phalotris concolor Ferrarezzi, 1994	Cocos
	Phimophis guerini (Duméril, Bibron & Duméril, 1854)	Jaborandi, Cocos
	Pseudoboa nigra (Duméril, Bibron & Duméril, 1854)	Santa Maria da Vitória, Jaborandi, Correntina, São Desidério
	Helicops sp.	Barreiras, São Desidério, Cocos
	Rodriguesophis iglesiasi (Gomes, 1915)	São Desidério
	Thamnodynastes sp	Santa Maria da Vitória, Cocos, Coribe, Correntina
	Erythrolamprus poecilogyrus schotti (Schlegel, 1837)	Santa Maria da Vitória, Correntina, São Desidério
	Erythrolamprus viridis viridis (Günther, 1862)	Santa Maria da Vitória, São Félix do Coribe, Correntina
	Erythrolamprus aesculapii (Linnaeus, 1766)	Jaborandi
	Erythrolamprus almadensis (Wagler, 1824)	São Desidério
	Lygophis dilepis (Cope, 1862)	São Félix do Coribe, São Desidério, Correntina.
	Lygophis meridionalis (Schenkel, 1901)	Cocos
	Xenodon merremii (Wagler, 1824)	São Félix do Coribe, Santa Maria da Vitória, Cocos, Correntina, Jaborandi, São Desidério, Barreiras
Elapidae	*Micrurus brasiliensis* Roze, 1967	Correntina, São Desidério, Barreiras
Viperidae	*Bothrops leucurus* Wagler, 1824	Barreiras, São Desidério
	Bothrops lutzi (Mir, a-Ribeiro, 1915)	São Desidério, Jaborandi Barreiras, Cocos, São Félix do Coribe
	Bothrops moojeni Hoge, 1966	São Desidério, Correntina, Cocos, Barreiras
	Bothrops erythromelas Amaral, 1923	Correntina
	Crotalus durissus cascavella Wagler, 1824	Santa Maria da Vitória, Correntina, Cocos, São Félix do Coribe, São Desidério, Barreiras

Chico Mendes de Conservação da Biodiversidade for collecting road-killed animals.

A comparison between our study and previously published ones in other areas of the Cerrado domain was made.

RESULTS

One hundred twenty individuals comprising, 46 species of snakes from seven families (Table 1), were collected (Figures 2–5). The contacts between the Cerrado and semi-arid dry areas in northeastern Brazil are still poorly studied. Our inventory shows a large area of contact between the northeastern Cerrado and the Caatinga, including species from both domains in this contact zone.

Among the typical Caatinga species, we found the following in western Bahia Cerrado formations: *Epicrates assisi* Machado, 1945, *Tantilla marcovani* Lema, 2004, *Apostolepis polylepis* Amaral, 1921, *Boiruna sertaneja* Zaher, 1996, *Thamnodynastes* sp., *Erythrolamprus viridis viridis* (Günther, 1862), *Lygophis dilepis* (Cope, 1862) and *Bothrops erythromelas* Amaral, 1923.

Among the species usually found in Cerrado we highlight: *Liotyphlops ternetzii* (Boulenger, 1896), *Trilepida koppesi* (Amaral, 1955), *Trilepida brasiliensis* (Laurent, 1949), *Boa constrictor amarali* Stull, 1932, *Epicrates crassus* Cope, 1862, *Chironius flavolineatus* (Jan, 1863), *Phalotris concolor* Ferrarezzi, 1993, *Apostolepis ammodites* Ferrarezzi, Barbo & Albuquerque, 2005, *Philodryas agassizii* (Jan, 1863), *Phimophis guerini* (Duméril, Bibron & Duméril, 1854), *Lygophis meridionalis* (Schenkel, 1901), *Micrurus brasiliensis* Roze, 1967, *Bothrops lutzi* (Miranda-Ribeiro, 1915) and *Bothrops moojeni* Hoge, 1966. Therefore, there is a greater predominance of Cerrado over Caatinga species. Additionally, in this region, we found another 22 species that are widely distributed throughout Brazil in other morphoclimatic domains.

We also discovered a presumed new species belonging to the genus *Thamnodynastes* Wagler, 1830 (Figure 3E), and *Phalotris concolor* (CHUNB 17435, 51553). This specimen, a male, with a combination of uniform light brown dorsal coloration, 1+1 temporal scales, blotched infralabial and gular region, 202 ventral scales and 36 subcaudal scales, falls within the variation described by Moura et al (2013). This is the first record of *Phalotris* from the state of Bahia and highlights the need for more taxonomic studies with this genus.

DISCUSSION

The average number of snake species found in each of the previous inventories (Table 2) is 36. The highest species richness, 61 (França et al. 2004, 2008), was found in Brasília in Distrito Federal.

Table 1 shows the number of species of snakes found in different Cerrado areas in Brazil, including small enclaves of Cerrado within the Caatinga domain (Freitas et al. 2012; Ribeiro et al. 2012).

Knowledge of the biodiversity of a region is the main tool for discussing conservation of ecosystems and wildlife populations. Our inventory shows that the Cerrado of western Bahia has a relatively high species richness of snakes for the region and is higher than the average found in 15 prior inventories conducted within the Cerrado domain.

The diversity of Cerrado snakes of western Bahia includes 14 typical predominant and almost exclusive species of the Brazilian Cerrado, 24 species of wide distribution in many areas of vegetation of Brazil, and only eight species typical and almost exclusive to the Caatinga domain.

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Table 2. Comparisons between different studies inventorying snakes in the Cerrado biome.

Study	Municipality	State	Family	Species	Also occurs in Western Bahia
Silva-Jr. et al. (2009)	Itiquira	Mato Grosso	8	40	21
Vaz-Silva et al. (2007)	Aporé	Goiás	7	45	23
Sawaya et al. (2008)	Itirapina	São Paulo	6	36	18
Recoder and Nogueira (2007)	Chapada Gaucha	Minas Gerais	6	22	15
Carvalho and Nogueira (1998)	Cuiabá	Mato Grosso	4	36	18
São Pedro and Pires (2009)	Ouro Branco	Minas Gerais	5	28	11
Valdujo et al. (2009)	Mineiros	Goiás	8	54	25
Recoder et al. (2011)	Mateiros	Tocantins	7	21	12
Cintra et al. (2009)	Mambaí	Goiás	8	28	19
Pavan and Dixo (2004)	Palmas	Tocantins	9	59	28
Freitas et al. 2012	Mucugê	Bahia	6	35	21
Ribeiro et al. (2012)	Crato	Ceará	7	43	22
França et al. (2008)	Brasília	Distrito Federal	6	61	25
França and Braz (2013)	Alto Paraíso	Goiás	7	47	28
Costa et al. (2014)	Nova Ponte	Minas Gerais	6	43	19
Current study	Western Bahia	Bahia	7	46	

Figure 2. Snakes recorded in the Cerrado of western Bahia. **A:** *Leptophis ahaetulla*, São Desidério (photo by Luiz Trinchão). **B:** *Lygophis dilepis*, Jaborandi (photo by Renato Gaiga). **C:** *Liotyphlops ternetzii*, São Desidério (photo by Luiz Trinchão). **D:** *Micrurus brasiliensis*, São Desidério (photo by Luiz Trinchão). **E:** *Oxybelis aeneus*, São Desidério (photo by Luiz Trinchão). **F:** *Phimophis guerini*, Jaborandi (photo by Marco Freitas). **G:** *Oxyrhopus trigeminus*, Jaborandi (photo by Marco Freitas). **H:** *Philodryas nattereri*, road-killed, Correntina (photo by Marco Freitas).

Figure 3. Snakes recorded in the Cerrado of western Bahia. **A:** *Pseudoboa nigra*, São Desidério (photo by Luiz Trinchão). **B:** *Spilotes pullatus*, São Desidério (photo by Luiz Trinchão). **C:** *Bothrops leucurus*, São Desidério (photo by Luiz Trinchão). **D:** *Bothrops moojeni*, Cocos (photo by Marco Freitas). **E:** *Thamnodynastes* sp., Santa Maria da Vitória (photo by Marco Freitas). **F:** *Trilepida koppesi*, São Desidério (photo by Marco Freitas). **G:** *Tantilla marcovani*, São Desidério (photo by Marco Freitas). **H:** *Xenodon merremii*, São Desidério (photo by Luiz Trinchão).

Figure 4. Snakes recorded in the Cerrado of western Bahia. **A:** *Apostolepis ammodites* Correntina (photo by Marco Freitas). **B:** *Apostolepis polylepis*, São Desidério (photo by Luiz Trinchão). **C:** *Boiruna sertaneja*, Santa Maria da Vitória (photo by Marco Freitas). **D:** *Boa constrictor amarali*, Barreiras (photo by Marco Freitas). **E:** *Boa constrictor constrictor* Santa Maria da Vitória (photo by Marco Freitas). **F:** *Bothrops lutzi*, Jaborandi (photo by Renato Gaiga). **G:** *Corallus hortulanus*, São Desidério (photo by Luiz Trinchão). **H:** *Chironius flavolineatus*, São Desidério (photo by Luiz Trinchão).

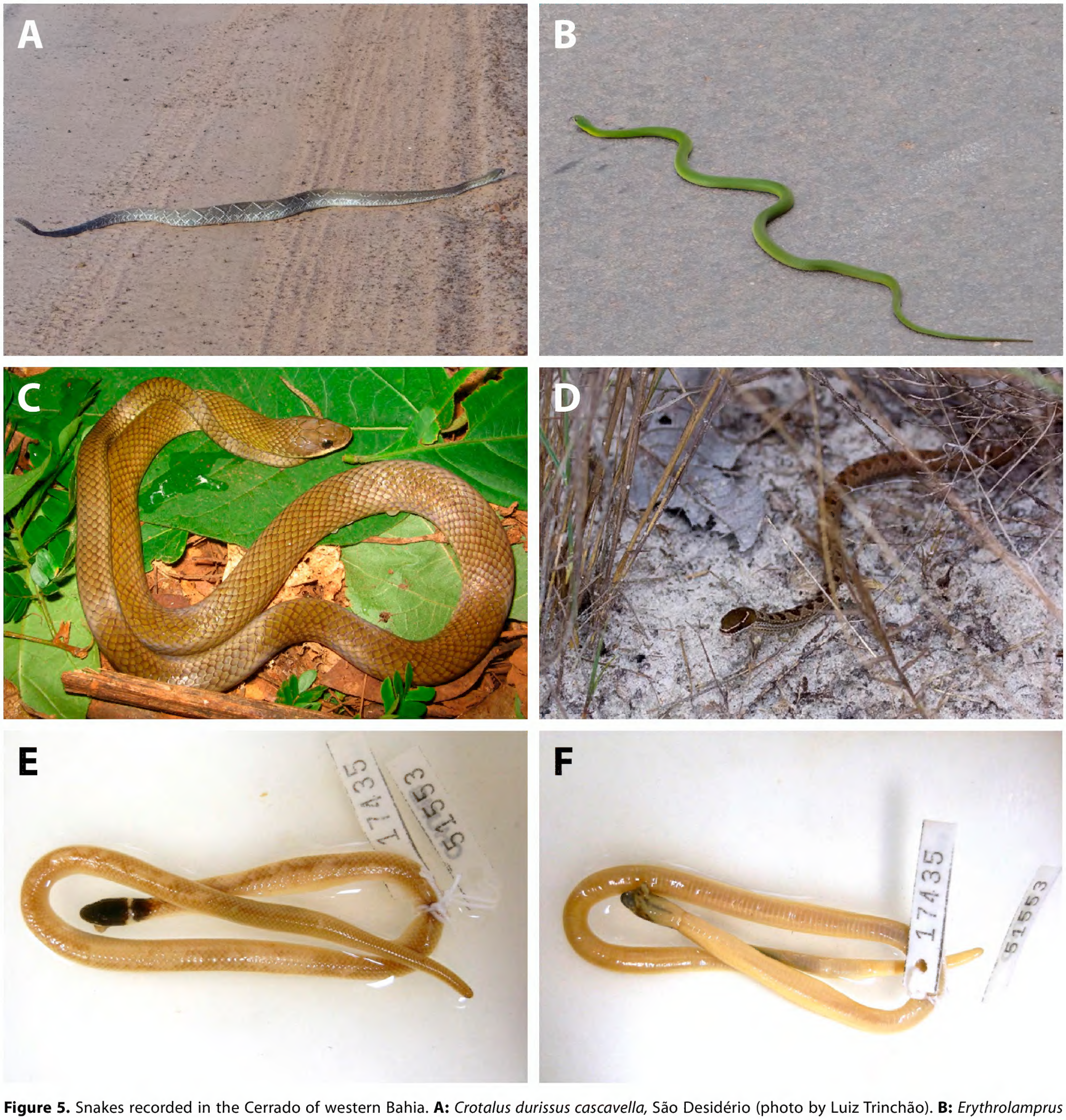

Figure 5. Snakes recorded in the Cerrado of western Bahia. **A:** *Crotalus durissus cascavella,* São Desidério (photo by Luiz Trinchão). **B:** *Erythrolamprus viridis,* São Desidério (photo by Luiz Trinchão). **C:** *Erythrolamprus poecilogyrus schooti,* Santa Maria da Vitória (photo by Marco Freitas). **D:** *Taeniophallus* gr. *occipitalis,* São Desidério (photo by Sidnei Sampaio). **E:** dorsal view of *Phalotris concolor,* CHUNB (photo by Arthur Senna). **F:** ventral view of *Phalotris concolor*, CHUNB (photo by Arthur Senna).

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APPENDIX 1

Voucher specimens.

Trilepida koppesi: MZUESC 8188, *São* Desidério. *Trilepida brasiliensis*: CHUNB 38644, 51368, Cocos. *Epicrates assisi*: MZUESC 8201, Barreiras. *Epicrates crassus*: CHUNB 38643, Cocos. *Mastigodryas bifossatus*: CHUNB 06642, Correntina. *Oxybelis aeneus*: MZUESC 8172, São Desidério; MZUESC 8179, Correntina; CHUNB 23714, 50183, Cocos. *Leptophis ahaetulla*: CHUNB 06640, Coribe. *Tantilla marcovani*: MZUESC 8187, *São* Desidério; *Tantila* sp.: CHUNB 50187, 50188, 50268, 50269, 51361, 51367, 51553, 51362, Cocos; CHUNB 03905, Correntina; CHUNB 57516, 62474, Jabor, i. *Taeniophalus* sp.: CHUNB 50191, 51552, Cocos. *Apostolepis ammodites*: MZUESC 8180, Correntina; CHUNB 51360, Cocos. *Apostolepis* sp.: CHUNB 23715, 39079, Correntina. *Philodryas nattereri*: MZUESC 8174–8177, CHUNB 03603, 03609, 40657, Correntina; MZUESC 8193, 12065, 12066, *São* Desidério. *Philodryas olfersii*: CHUNB 03631, Coribe. *Philodryas patagoniensis*: CHUNB 51369–51373, Cocos. *Philodryas agassizii*: CHUNB 40658, Correntina. *Sibynomorphus mikanii*: CHUNB 03856, Correntina. *Boiruna sertaneja*: MZUESC 8185, Santa Maria da Vitória; CHUNB 51135, Jabor, i. *Oxyrhopus trigeminus*: MZUESC 8184, Santa Maria da Vitória; CHUNB 23713, Cocos; CHUNB 51118, Jabor, i. *Oxyrhopus guibei*: CHUNB 03655, Correntina; CHUNB 03663, 03656, Barreiras. *Phalotris* cf. *concolor*: CHUNB 17435, 51553, Cocos. *Phimophis guerini*: CHUNB 23789, 23790, 15612, 50189, 50271, Cocos; CHUNB 62398, Jabor, i. *Rodriguesophis* sp.: MZUSP-MTR 17851, 17863, 17963, *São* Desidério. *Pseudoboa nigra*: MZUESC 12067, *São* Desidério; MZUESC 8173, Correntina; CHUNB 62473, Jabor, i. *Helicops* sp.: CHUNB 71343, Barreiras; CHUNB 42548, Cocos. *Thamnodynastes* sp.: CHUNB 42549, Cocos; CHUNB 03838, Coribe. *Erythrolamprus poecilogyrus schotti*: MZUESC 8178, Correntina. *Erythrolamprus viridis*: MZUESC 8195, *São Félix do* Coribe. *Erythrolamprus aesculapii*: CHUNB 62475, Jabor, i. *Lygophis dilepis*: MZUESC 8194, *São Félix do* Coribe; MZUESC 12068, *São* Desidério. *Lygophis meridionalis*: CHUNB 50190, Cocos. *Xenodon merremii*: MZUESC 12062–12064, *São* Desidério; CHUNB 06057–06061, Barreiras; CHUNB 05879, 23788, 30912, Cocos; CHUNB 62422, Jabor, i. *Micrurus brasiliensis*: CHUNB 03915, Barreiras; CHUNB 39081, Correntina. *Bothrops lutzi*: CHUNB 06634, Barreiras; CHUNB 51363–21366, 50185, 50186, 23793, 13873, Cocos; CHUNB 51133, Jabor, i. *Bothrops moojeni*: MZUESC 8171, *São* Desidério; CHUNB 06631, 03995, 03992, Correntina; CHUNB 50184, Cocos. *Bothrops erythromelas*: CHUNB 03592, Correntina. *Crotalus durissus*: CHUNB 05872–05878, 06063, 67519, Barreiras; CHUNB 49195, Cocos; CHUNB 05449–05451, Correntina.